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0407210.4

3. Full name, address and postcode of the or of each applicant (underline all surnames)

JOHN WARD CEYLON (PRIVATE) LIMITED  
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Patents ADP number (if you know it)

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F01/7700 0.00-0407210.4 CHERQUE

If the applicant is a corporate body, give the country/state of its incorporation

Sri Lanka

4. Title of the invention POLYMERIC GARMENT MATERIAL

5. Name of your agent (if you have one) Barker Brettell

"Address for service" in the United Kingdom to which all correspondence should be sent (including the postcode)

138 Hagley Road  
Edgbaston  
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B16 9PW

Patents ADP number (if you know it)

7442494002 ✓

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Statement of inventorship and right to grant of a patent (*Patents Form 7/77*)Request for preliminary examination YES -1  
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11. I/We request the grant of a patent on the basis of this application.

Signature  
  
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Alan S. Wilson

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## POLYMERIC GARMENT MATERIAL

This invention relates to polymeric garment material, garments and methods of making polymeric garment material.

5

Polymeric materials are currently used for a wide range of garments, some of these garments (for example, raincoats and aprons) make use of the protective properties of the material, other garments (for example, footwear, underwear and fashion garments) use polymeric materials  
10 because of appearance and/or feel of the material.

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Figure 1 illustrates the steps of a known method of producing a knitted nylon garment that has a polyurethane (PU) coating. At step 10 a knitted nylon lining is fitted on to a mould. The nylon lining acts as a substrate to  
15 which the PU coating is applied. Figure 2 illustrates a sock lining 32 fitted to a mould 30 that supports the lining 32 so that the lining 32 takes the desired shape for the finished garment. In the case illustrated the garment is a sock, however, the method is applicable to other garments.  
At step 12 the mould 30 (fitted with the sock lining 32) is immersed into  
20 a solution of PU and dimethylformamide (DMF). At step 14 the mould 30 is withdrawn from the solution of PU and DMF and excess solution is allowed to drain leaving a coating of the PU/DMF solution on the lining 32. At step 16 the mould is immersed in water. The immersion causes the PU coating on the lining 32 to coagulate, that is the PU coating sets. The  
25 mould 30 remains in the water for a period of 90 to 120 minutes so that the DMF solvent is leached out of the lining into the water. At step 18 the mould is removed from the water and placed in an oven to dry the PU coated nylon liner. Finally at step 20 the PU coated nylon liner is removed from the mould 30 and a PU coated nylon sock is obtained.

A major disadvantage with this process is that it uses DMF. DMF is a solvent that is known to be very toxic, and one that is easily absorbed through the skin. Therefore great care has to be taken when handling the solution of PU/DMF. In order that a safe working environment is provided the atmosphere in which the process is carried out needs to be well ventilated and provided with extraction fans.

At step 16, when the DMF is leached into water, the water will become saturated with DMF. Therefore, the water will need to be repeatedly changed - this is both time consuming and expensive. Additionally, since the DMF saturated water solution is toxic, care must be taken when disposing of the DMF saturated water so as to minimise environmental damage that may occur from the disposal. There is also a health hazard to the wearer of a garment made by this process since not all the DMF may have been removed during the leaching step 16. The health hazard is increased if the garment is to be worn next to the skin.

A further disadvantage of the process is that the PU coating penetrates the interstices of the nylon liner. Therefore, the PU coating will come into contact with the skin of a wearer of a garment made by this process if such a garment is worn next to the skin. This can cause irritation and build up of perspiration next to the skin, and, in particular, some wearers may be allergic to PU.

According to a first aspect of the invention there is provided a method of making garment material, the method having the steps: applying coagulant to a substrate; applying a foam of the polymeric material to the substrate; allowing the coagulant to coagulate some of the foam; and removing uncoagulated foam from the substrate to leave a layer of coagulated polymeric material on the substrate.

The use of foamed (aerated) polymeric material removes the need for the polymeric material to be dissolved in DMF or, indeed, any other solvent. Therefore, the method is less hazardous and more environmentally friendly. The garment material produced by the method will not contain 5 potentially harmful traces of solvent.

A wide range of polymeric materials are suitable for production of the foam, these include nitrile latex, natural latex, polyvinylchloride (PVC), polyvinylacetate (PVA) neoprene (polychloroprene) and rubber as well as 10 PU latex. The foam may be produced from a mixture of two or more of these polymeric materials. Hence, the method provided by the invention is more widely applicable than the known method (illustrated in Figure 1), which is restricted to the use of PU.

15 The substrate may be, for example, knitted nylon but a wide range of materials may be used as the substrate, for example, the substrate may be one of, or a blend of two or more of: cotton, spandex, lycra, polyester, aramid, dyneema, acrylic, carbon conductive fibre, copper conductive fibre, thunderon conductive fibre, multifilament yarn spun from liquid 20 crystal polymer (available under the brand name Vectran™), tactel, CoolMax™, ThermaStat™ and Thermax™.

25 Preferably, the step of removing the uncoagulated foam comprises directing a fluid at the substrate. For example a spray of liquid such as water may be directed at the substrate.

Surprisingly, this method of removing the excess, uncoagulated foam leaves behind a cohesive, porous and breathable layer of polymeric material on the substrate. A garment made from the garment material 30 produced in this way allows perspiration to escape from wearer of the garment and reduces heat build up within the garment.

The garment material is more flexible and lightweight and garments made from the garment material are more comfortable to wear than garments produced by the prior art method illustrated in Figure 1.

5

The penetration of the foam into the substrate may be controlled so that the foam does not fully penetrate the substrate. In this way, the garment material produced has an inner surface that does not have exposed polymeric material. This is advantageous since many people have an allergic reaction to polymeric materials (especially latex) worn next to the skin and the non penetrated portion of the substrate forms a barrier between the wearer of the garment and the coating of the polymeric material.

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10 15 According to a second aspect of the invention there is provided garment material produced by the method of the first aspect of the invention.

According to a third aspect of the invention there is provided a garment produced by the method of the first aspect of the invention.

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According to a fourth aspect of the invention there is provided a garment or garment material having a substrate and a layer of coagulated polymeric material penetrating at least partially the substrate, the garment or garment material having a water vapour permeability in the range 3.5  
25 to 6.5 mg.cm<sup>-2</sup>.h<sup>-1</sup>.

30 According to a fifth aspect of the invention there is provided a garment or garment material having a substrate and a layer of coagulated polymeric material penetrating the substrate, wherein the polymeric material does not fully penetrate the substrate.

According to a sixth aspect of the invention there is provided a garment or garment material having a substrate and a layer of coagulated polymeric material penetrating at least partially the substrate, wherein the garment or garment material has a water vapour permeability in the range

5      3.5 to 6.5 mg.cm<sup>-2</sup>.h<sup>-1</sup>.

Preferably the garment or garment material has a water vapour permeability in the range 5.0 to 6.5 mg.cm<sup>-2</sup>.h<sup>-1</sup>.

10     According to a seventh aspect of the invention there is provided a garment or garment material which, when subjected to a temperature of  $20 \pm 2$  °C and a relative humidity of  $65 \pm 2\%$  for 265 minutes, will hold between 1.0 mg and 8.5 mg of water per cm<sup>2</sup> of the garment or garment material.

15

Preferably the garment or garment material, when subjected to a temperature of  $20 \pm 2$  °C and a relative humidity of  $65 \pm 2\%$  for 265 minutes, will hold between 1.0 mg and 5.5 mg of water per cm<sup>2</sup> of the garment or garment material.

20

Preferred embodiments of the present invention will now be described, by way of example only, with reference to the accompanying drawings in which:

25     Figure 1 schematically illustrates a prior art method of making polyurethane coated garments;

Figure 2 schematically illustrates a substrate that has been placed on a mould;

30

**Figure 3** schematically illustrates a method of making garment material according to an embodiment of the invention;

5      **Figure 4** schematically illustrates a system for making garment material according to an embodiment of the invention;

**Figure 5** schematically illustrates a plan view of a flight bar to which several moulds are mounted;

10     **Figure 6** schematically illustrates a side view of the flight bar of Figure 5, the flight bar being translated into a spraying station;

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15     **Figure 7** schematically illustrates a side view of a garment substrate in a section of the spraying station of Figure 7 in which nozzles are pointing upwards;

20     **Figure 8** schematically illustrates a side view of a garment substrate in a section of the spraying station of Figure 7, in which nozzles are pointing horizontally; and

25     **Figure 9** schematically illustrates a side view of a garment substrate in a section of the spraying station of Figure 7, in which nozzles are pointing downwards.

30     Referring to Figures 3 and 4, to make a garment according to an embodiment of the invention, at step 210 a lining or substrate 32 is fitted to a mould 30. The mould 30 supports the substrate 32 during the various process steps that are applied to the substrate 32 to produce the garment material. After the garment material has been made it is removed from the mould 30.

The substrate 32 may take the form of a complete garment, for example, a sock (as is illustrated in Figure 2) or in a form that is a section of a garment, for example a pocket for a coat. In such cases the mould 32 provides the correct shape for the finished garment or garment section.

5 When the mould takes the shape of a finished garment it is preferable that the substrate 32 fitted on to the mould 30 is seamless so that the finished garment is also seamless. Alternatively, the mould 32 need not take any particular form and sheets of garment material are formed by the process. For example, the substrate may be stretched out between two clamps or

10 rollers, and for the purpose of this specification the term "mould" covers arrangements of clamps, rollers and the like that support the substrate 32 by applying tension to the substrate 32. In this case, garment or garment sections are produced by further processing of the sheets of garment material for example by pieces being cut from the sheet of garment

15 material and then the pieces being used to make a garment.

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The mould 30 may be made from, for example, metal, porcelain, fibreglass or plastic.

20 Suitable materials for the substrate 32 include one of, or a blend of two or more of: nylon, cotton, spandex, lycra, polyester, aramid, dyneema, acrylic, carbon conductive fibre, copper conductive fibre, thunderon conductive fibre, multifilament yarn spun from liquid crystal polymer (available under the brand name Vectran™), tactel, CoolMax™,

25 ThermaStat™ and Thermax™. The substrate 32 has a lattice structure and may be formed by knitting, weaving or some other known process.

The process may be applied to batches of substrates ('batch-processing) such that the process steps are applied to a group of moulds 30, each

30 mould 30 supporting a substrate 32. Alternatively, the process may be applied continuously such that the moulds 30 are continuously translated

through the system 100. Of course, the moulds 30 may be continuously translated through some parts of the system 100 and stationary for periods of time at other parts of the system 100 according to what particular process step is occurring at those positions. Referring to Figure 5, the 5 moulds 30, bearing the substrates 32 are mounted in a row on a bar 50, termed a "flight bar". In the example illustrated, four pairs of moulds 30 (bearing four pairs of gloves respectively) are mounted on a flight bar 50. The flight bar 50 moves in a linear direction from one process station to another at a set speed. There may be several flight bars 50, each flight 10 bar 50 being at a different stage of the process, and the movement of a flight bar 50 from one station to the next is at set intervals.

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At step 214 coagulant 34 is applied to the substrate 32. This maybe achieved by immersing the substrate 32 (supported on the mould 30) into 15 a bath or trough 36 containing the coagulant 34 or by spraying the coagulant 34 onto the substrate 32. The coagulant 34 is an aqueous or alcoholic solution of electrolytes. Suitable electrolytes include formic acid, acetic acid, calcium nitrate, calcium chloride or a mixture of two or more of these. Ethanol may be used to provide the alcoholic solution of 20 electrolytes but other alcohols are also suitable, for example, iso-propyl alcohol and methanol may also be used.

At step 218 excess coagulant 34, i.e. coagulant that is not absorbed by the substrate 32 is allowed to drain from the substrate 32. If the coagulant 34 25 was applied by immersion in a bath/trough 36 of coagulant 34 then step 218 involves withdrawal of the mould 30 from the bath/trough 36.

At step 222 a foam 38 of polymeric material is applied to the substrate 32, for example by immersing the mould 30 supporting the substrate 32 30 into a bath/trough 37 of the foam 38. The production of a foam 38 of polymeric material is well known to a skilled person. The foam 38 may

be formed from one of, or combination of, several polymeric materials. Suitable polymeric materials include PU latex, nitrile latex, natural latex, polyvinylchloride (PVC), polyvinylacetate (PVA), neoprene (polychloroprene) and rubber. The foam 38 has a density in the range 15-35%, i.e. there is 15-35 % air by volume in the foam and a viscosity in the range 80-180 poise (8-18 Ns/m<sup>2</sup>). The foam 38 contains thickeners so that the foam 38 is of the required viscosity. The thickeners are usually added to the polymeric material when the polymeric material is in liquid form, i.e. before it is aerated. Examples of thickeners include polyvinyl alcohol (0.2 - 0.6 parts per 100 parts polymeric material by volume) methyl cellulose (0.2 - 0.8 parts per 100 parts polymeric material by volume) and polyacrylate (0.2 - 0.6 parts per 100 parts polymeric material by volume). The foam also contains stabilisers so that the foam 38 is stable (i.e. does not degrade to a liquid) and curatives that provide the polymeric coating obtained from the foam with mechanical strength so that the coating is resistant to, for example, abrasion, punctures and tearing. The stabilisers and curatives are usually added to the polymeric material when the polymeric material is in liquid form. Examples of stabilisers include diphenyl guanidine alcohol (with a concentration of about 0.5 parts per 100 parts polymeric material by volume) and alkali casein (0.3 - 0.8 parts per 100 parts polymeric material by volume). Although the thickeners, stabilisers and curatives are normally added to the liquid polymeric material before it is aerated, they can also be added after aeration, for example if modification of the foam properties is required (for example by adding more thickener to increase the viscosity of the foam).

At step 226 the substrate 32 is removed from the foam 38 and excess foam is allowed to drain from the substrate 32 to leave a layer of foam 38 on the substrate 32. The foam is arranged, as described in more detail below, not to pass through the substrate 32, but to remain on the outer

surface or pass part way through the substrate. The foam therefore forms a layer on the outside of the substrate 32.

At step 228 the foam 38 reacts with the coagulant 34 that has been  
5 absorbed by the substrate 32 causing coagulation of the foam 38.

Only partial coagulation of the foam 38 is required, therefore, the foam 38 is allowed to react with the coagulant 34 for a limited period of time.  
After this period of time the coagulant closest to the substrate 32 will be  
10 coagulated but the degree of coagulation progressively decreases with distance from the substrate 32 so that the outer surface of the foam will not be coagulated (i.e., the outer surface will be wet). Typically the foam 38 is allowed to react with the coagulant 34 for a period in the range of 60-180 seconds before the excess (uncoagulated) foam 38 is removed.  
15 This period is controlled so that the underside of the foam layer that is in contact with the substrate 32 coagulates, but the outer part of the foam layer does not coagulate. Therefore, a film skin is not formed on the outer surface of the foam layer. The foam layer has a thickness in the range 0.5 - 1.5 mm.  
20 At step 230 the outer layer of excess, uncoagulated foam 38 is removed from substantially the whole area of the foam layer on the substrate 32. This may be done by directing one or more sprays of water 40 at the substrate 32. The water is directed at the substrate 32 via one or more nozzles 42. Each spray of water 40 has a pressure in the range 1 - 4 bar (1 x 10<sup>5</sup> - 4 x 10<sup>5</sup> N/m<sup>2</sup>). The spraying process lasts for about 5 - 20 seconds.

The nozzles 42 may be stationary with a set orientation relative to the  
30 substrate 32. Alternatively, the nozzles 42 may be moveable so that the orientation of the nozzle 42 relative to the substrate 32 can be varied

during the spraying process. The nozzles 42 may also be translatable relative to substrate 32 during the spraying process to provide good coverage of the substrate 32 with the spray 40. It is also possible to use a continuous jet instead of a spray, however, a spray is preferred since this  
5 makes more economical use of water.

Referring to Figures 6 to 9, according to an embodiment of the invention the moulds 30, bearing the substrates 32, are translated on a flight bar 50 to a spraying station 52. Figures 6 to 9 illustrate the substrate 32 in the  
10 form of a glove lining with the fingers of the glove lining pointing downwards (of course the invention is applicable to sock linings and other garment substrates). The spraying station 52 comprises a number of spray nozzles 42. The nozzles form two rows 43 that are orientated so that the nozzles of one row sprays the front of the substrate 32 (e.g. the palm side  
15 of the glove linings 32) whilst the nozzles of the other row spray the back of the substrate 32 (e.g. the backhand side of the glove linings 32). The nozzles 42 are in a fixed position with a pre-set spraying angle and the nozzles 42 do not move during the spraying process. The spraying angle of each nozzle 42 is in the range 0 to 45° to the horizontal (the horizontal  
20 being the normal to the surface of the substrate 32) and the spraying angle may be adjusted before the spraying process. The nozzles 42 may be arranged as pairs with a nozzle 42a on one row facing a nozzle 42b of the other row. The nozzles 42a, 42b may be set at different angles: for example the pair of nozzles 42a, 42b may point upwards at about 45° to  
25 the horizontal as illustrated in Figure 7; the nozzles 42a, 42b may point horizontally as illustrated in Figure 8; or the nozzles 42a, 42b may point downwards at 45° to the horizontal illustrated in Figure 9. It is not necessary for the nozzles 42a, 42b in each pair to be orientated at the same angle to the horizontal.

As water is pumped through the nozzles 42 the flight bar 50 is translated vertically through the spray produced by the nozzles 42. For example, the moulds 30 are first moved downwardly through the sprays and then upwardly through the spray as the moulds are moved through the spraying station on the flight bar 50.

Other fluids could be used to remove the foam 38, for example a jet of compressed air could be directed at the substrate 32. The foam 38 could also be removed by immersing the substrate 32 in a bath/trough of an aqueous medium. The aqueous medium may comprise an anti-foam agent such as an emulsion of organo-modified polysiloxanes in the concentration range 0.01 - 0.1% by volume or a blend of petroleum and amorphous silica in the concentration range 0.2 - 0.8% by volume.

- 15 The removal of the excess foam 38, by directing fluid at the substrate 32, leaves behind a cohesive, porous and breathable layer of polymeric material on the substrate 32. At this stage of the process the layer of polymeric material has a thickness in the range 0.34 - 1.0 mm.
- 20 At step 232 excess coagulant 34 is removed from the substrate 32. This may be done by immersing the substrate 32 into a bath/trough of water 41; typically the immersion is for a period of about 15 minutes.

At step 234 the substrate 32 with its layer of polymeric material is dried.

- 25 The drying may be done in an oven 44 which may be fitted with one or more fans that distribute the heat evenly throughout the oven 44. The drying could also be achieved by directing air over the substrate 32. The air may be dried and/or heated before it is directed over the substrate 32.
- 30 After being dried, the layer of polymeric material has a thickness in the range 0.26 - 0.80 mm.

At step 236, the garment material, comprising the substrate 32 with the polymeric coating, is removed from the mould 30.

5 The garment material produced by the above process has a uniform porosity.

The penetration of the foam 38 into the substrate 32 can be controlled so that the foam does not fully penetrate the substrate 32. In this way, the 10 garment material produced has an inner surface that no, or very little, exposed polymeric material. This is advantageous since many people are have an allergic reaction to polymeric materials (especially latex) worn next to the skin and the non penetrated portion of the substrate 32 would form a barrier between the wearer of the garment and the coating of the 15 polymeric material.

The penetration of the foam into the substrate (and the porosity of the finished garment material) can be controlled by varying a number of parameters including:

20

- i. the formulation of the polymeric material;
- ii. the formulation of the coagulant;
- iii. the time between applying the coagulant and applying the foam;
- iv. the time between applying the foam and removing excess (uncoagulated) foam;
- v. foam density;
- vi. foam viscosity; and
- vii. the weight and construction of the substrate.

30 The parameter values disclosed in the description provide fabric material that has the desired properties, however, the skilled person may achieve

the advantages of the invention using a method having parameters that vary from those given.

The garment material produced by the invention is particularly suitable

5 for gloves, for example gardening gloves and gloves used for light assembly (for example the assembly of electronic components). Such gloves (particularly gloves for light assembly) need to provide the wearer with a high degree of dexterity and, when the gloves are worn for a long period of time, the hands need to be kept cool, dry and comfortable.

10 Gloves made by the process of the invention allow perspiration to escape from the glove/be absorbed by the glove and the hands of the wearer are not irritated by the glove (either by heat build up, sweat, solvent residue or polymeric material present on the lining of the glove). The increased flexibility of the polymeric coating, compared to the coatings of prior art

15 garment material, allows for better dexterity and usability of the gloves.

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Gloves made according to the invention were tested for water vapour permeability and absorption of water. The tests were performed on samples taken from four different gloves at a temperature of  $20 \pm 2$  °C

20 and a relative humidity of  $65 \pm 2\%$ . The thickness of all these samples was 1.08mm. The results of these tests are given in table 1.

For comparison, samples from four prior art gloves were also tested under the same conditions. The prior art gloves were made by using a

25 solution of polyurethane (PU) dissolved in DMF according to the method illustrated in Figure 1. The thickness of each of these samples was 1.03 mm with an area of 18 cm<sup>2</sup>. The results for these tests are given in Table 2.

30 The water vapour permeability figures are given in units of milligrams of water that pass through a square centimetre of the sample in one hour

( $\text{mg.cm}^{-2}.\text{h}^{-1}$ ). The absorption figures are given in milligrams of water absorbed by the whole sample as measured, with equivalents per square centimetre of the samples in brackets, after set periods of time at a temperature of  $20 \pm 2^\circ\text{C}$  and a relative humidity of  $65 \pm 2\%$ .

5

**Table 1 Test results for samples taken from gloves according to an embodiment of the invention**

	Sample 1	Sample 2	Sample 3	Sample 4
Permeability ( $\text{mg.cm}^{-2}.\text{h}^{-1}$ )	5.77	3.94	6.16	5.38
Absorption (mg.) after 265 minutes	45 ( $2.5 \text{ cm}^{-2}$ )	111 ( $6.2 \text{ cm}^{-2}$ )	32 ( $1.8 \text{ cm}^{-2}$ )	67 ( $3.7 \text{ cm}^{-2}$ )
Absorption (mg.) after 400 minutes	44 ( $2.4 \text{ cm}^{-2}$ )	143 ( $7.9 \text{ cm}^{-2}$ )	28 ( $1.6 \text{ cm}^{-2}$ )	69 ( $3.8 \text{ cm}^{-2}$ )

10

**Table 2 Test results for samples taken from prior art gloves made using a solution of PU in DMF**

	Sample 1	Sample 2	Sample 3	Sample 4
Permeability ( $\text{mg.cm}^{-2}.\text{h}^{-1}$ )	10.47	10.39	10.47	10.33
Absorption (mg.) after 265 minutes	1 ( $0.06 \text{ cm}^{-2}$ )	2 ( $0.11 \text{ cm}^{-2}$ )	3 ( $0.17 \text{ cm}^{-2}$ )	1 ( $0.06 \text{ cm}^{-2}$ )
Absorption (mg.) after 400 minutes	3 ( $0.17 \text{ cm}^{-2}$ )	1 ( $0.06 \text{ cm}^{-2}$ )	2 ( $0.11 \text{ cm}^{-2}$ )	0 ( $0 \text{ cm}^{-2}$ )

15

The average permeability of the samples taken from the gloves according to embodiment of the invention was  $5.3 \text{ mg.cm}^{-2}.\text{h}^{-1}$  whereas for the samples taken from the prior art gloves the average permeability was  $10.4 \text{ mg.cm}^{-2}.\text{h}^{-1}$ .

5

The tests were performed by an independent test organisation (SATRA Technology Centre, Kettering, Northamptonshire, UK). This organisation uses the following classification for water vapour permeability:

10	Very High permeability	- over $5.0 \text{ mg.cm}^{-2}.\text{h}^{-1}$
	High permeability	- between $2.6$ and $5.0 \text{ mg.cm}^{-2}.\text{h}^{-1}$
	Moderate permeability	- between $1.0$ and $2.5 \text{ mg.cm}^{-2}.\text{h}^{-1}$
	Low permeability	- under $1.0 \text{ mg.cm}^{-2}.\text{h}^{-1}$

15      Therefore, both sets of samples can be considered to have very high permeability (with the exception of sample 2 of Table 1). It can be seen that the permeability of the prior art gloves is much higher than the gloves made according to the method of this invention. However, when the gloves of the current invention are worn there is significantly less  
 20     build of perspiration than when the prior art gloves are worn. This can be explained by considering the absorption figures: the gloves embodying the invention absorb far more water than the prior art gloves. Therefore, for the gloves embodying the invention, when worn, some of the perspiration is taken from the hand of the wearer and held in the glove and some of  
 25     the perspiration permeates (i.e. escapes from) the glove, hence there is less perspiration build on the inner surface of the glove. It is believed that the gloves embodying the invention absorb more water because the polymer layer has larger interstitial spaces compared to the prior art due  
     to the method of manufacture of the gloves (i.e., the method of the  
 30     invention uses foamed polymer which is then washed off, for example with a water spray, before fully coagulating, whereas, for the prior art

method the glove liner/substrate is dipped in a solution of polymer and then immersed in water to coagulate the polymer solution). The interstitial spaces give the gloves a 'wicking action', that is water is pulled into the gloves by capillary action.

**CLAIMS**

1. A method of making garment material, the method having the steps:
  - 5 applying coagulant to a substrate;
  - 5 applying a foam of a polymeric material to the substrate;
  - allowing for the coagulant to coagulate some of the foam; and
  - removing uncoagulated foam from the substrate to leave a layer of coagulated polymeric material on the substrate.
- 10 2. The method according to claim 1, wherein the step of removing uncoagulated foam comprises removing an outer layer of the foam to leave an inner layer of coagulated polymeric material on the substrate.

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- 15 3. The method according to claim 2, wherein the outer layer is removed before a skin has formed on the outer surface of the foam layer.
4. The method of any one of claims 1 to 3, wherein the step of removing the uncoagulated foam comprises directing a fluid at the substrate.
- 20 5. The method of claim 4, wherein the fluid is a liquid.
6. The method of claim 5, wherein the liquid comprises water.
7. The method of claim 5 or 6, wherein liquid is directed as a spray.
- 25 8. The method of claim 7, wherein the spray has a pressure in the range 1 to 10 bar.
9. The method of claim 8, wherein the spray has a pressure in the range 1  
30 to 4 bar.

10. The method of claim 4, wherein the fluid is a gas.

11. The method of claim 10, wherein the gas is at least predominantly air.

5

12. The method of claim 10 or 11, wherein gas is directed as a jet.

13. The method of claim 12, wherein the jet has a pressure in the range 1 to 10 bar.

10

14. The method of claim 13, wherein the jet has a pressure in the range 1 to 4 bar.

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15. The method of any one of claims 4 to 14 wherein the fluid is directed at angle in the range  $0^\circ$  to  $45^\circ$  to the normal to the surface of the substrate.

16. The method of claim 1, wherein the step of removing uncoagulated foam from the substrate comprises immersing the substrate in liquid.

20

17. The method of claim 16 wherein the liquid comprises water.

18. The method of any previous claim wherein the substrate comprises knitted nylon.

25

19. The method of any previous claim comprising the step of immersing the substrate in water to remove coagulant after the step of removing the uncoagulated foam from the substrate.

30 20. The method of claim 19 comprising the step of drying the substrate after the step of immersing the substrate in water.

21. The method of claim 20 wherein the drying comprising placing the substrate in an oven.
- 5    22. The method of any previous claim, wherein the step of allowing the coagulant to coagulate some of the foam lasts for a period in the range 60 to 180 seconds.
- 10    23. The method of any previous claim, wherein the coagulant is an aqueous solution of one or more electrolytes.

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24. The method of any one of claims 1 to 22, wherein the coagulant is an alcoholic solution of one or more electrolytes.
- 15    25. The method of claim 23 or 24, wherein the one or more electrolytes comprise one or more of the following substances: formic acid, acetic acid, calcium nitrate and calcium chloride.
- 20    26. The method of any previous claim, wherein the polymeric material comprises one of: nitrile latex, natural latex, polyurethane latex, polyvinyl chloride latex, neoprene and polyvinylacetate.
- 25    27. The method of claim 26, wherein the polymeric material comprises a blend of two or more of: nitrile latex, natural latex, polyurethane latex, polyvinylchloride latex, neoprene and polyvinylacetate.
- 30    28. The method of any previous claim, wherein the substrate is placed on a mould before the coagulant is applied to the substrate.
- 30    29. The method of claim 28 wherein the mould is composed of one or more of the following materials: metal, ceramic, fibre glass and plastic.

30. The method of claim 28 or 29, wherein the mould takes the form a portion of a garment.

5     31. The method of claim 28 or 29, wherein the mould takes the form of a complete garment.

10    32. The method of any previous claim, wherein the garment is a garment chosen from one of the following: a coat, an apron, a boot, a shoe, a sock, an item of underwear, a glove, and a corset.

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33. A garment material produced by the method of any preceding claim.

15    34. The garment material of claim 33 having a water vapour permeability in the range  $3.5$  to  $6.5 \text{ mg.cm}^{-2}.\text{h}^{-1}$ .

20    35. The garment material of claim 33 or claim 34, when subjected to a temperature of  $20 \pm 2^\circ\text{C}$  and a relative humidity of  $65 \pm 2\%$  for 265 minutes, holding between  $1.0$  mg and  $8.5$  mg of water per  $\text{cm}^2$  of the garment material.

36. A garment produced by the method of any one of claims 1 to 32.

25    37. The garment of claim 36 having a water vapour permeability in the range  $3.5$  to  $6.5 \text{ mg.cm}^{-2}.\text{h}^{-1}$ .

30    38. The garment of claim 36 or claim 37, when subjected to a temperature of  $20 \pm 2^\circ\text{C}$  and a relative humidity of  $65 \pm 2\%$  for 265 minutes, holding between  $1.0$  mg and  $8.5$  mg of water per  $\text{cm}^2$  of the garment.

39. The garment of any one of claims 36 or 38, wherein the garment is a glove.

40. A garment or garment material having a substrate and a layer of  
5 coagulated polymeric material penetrating at least partially the substrate,  
wherein the garment or garment material has a water vapour permeability  
in the range 3.5 to 6.5 mg.cm<sup>-2</sup>.h<sup>-1</sup>.

41. The garment or garment material of claim 40, when subjected to a  
10 temperature of 20±2 °C and a relative humidity of 65±2% for 265  
minutes, holding between 1.0 mg and 8.5 mg of water per cm<sup>2</sup> of the  
garment or garment material

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42. A garment or garment material having a substrate and a layer of  
15 coagulated polymeric material penetrating the substrate, wherein the  
polymeric material does not fully penetrate the substrate.

43. The garment or garment material of any one of claims 40 to 42,  
wherein the garment is a glove.  
20

44. Apparatus for producing garment material comprising a mould  
arranged to support a substrate, foam application means arranged to apply  
foam of a polymeric material to the substrate, and foam removing means  
arranged to remove uncoagulated foam from the substrate to leave a layer  
25 of coagulated polymeric material on the substrate.

45. A method as hereinbefore described with reference to Figures 3 and  
4.

30 46. An apparatus as hereinbefore described with reference to Figure 4.

47. A garment as manufactured according to the method as hereinbefore described with reference to Figures 3 and 4.

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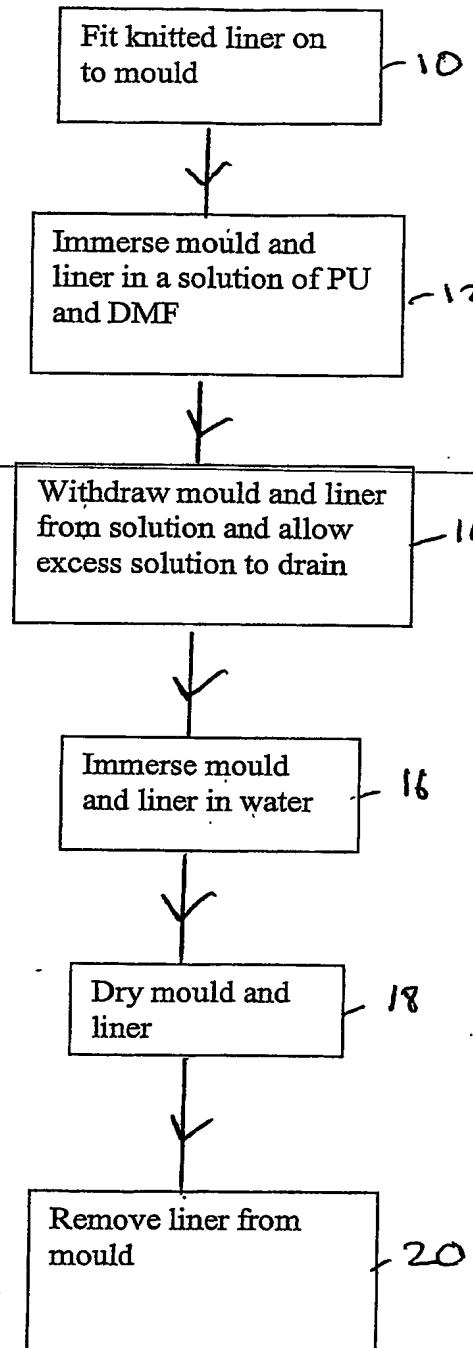


Figure 1

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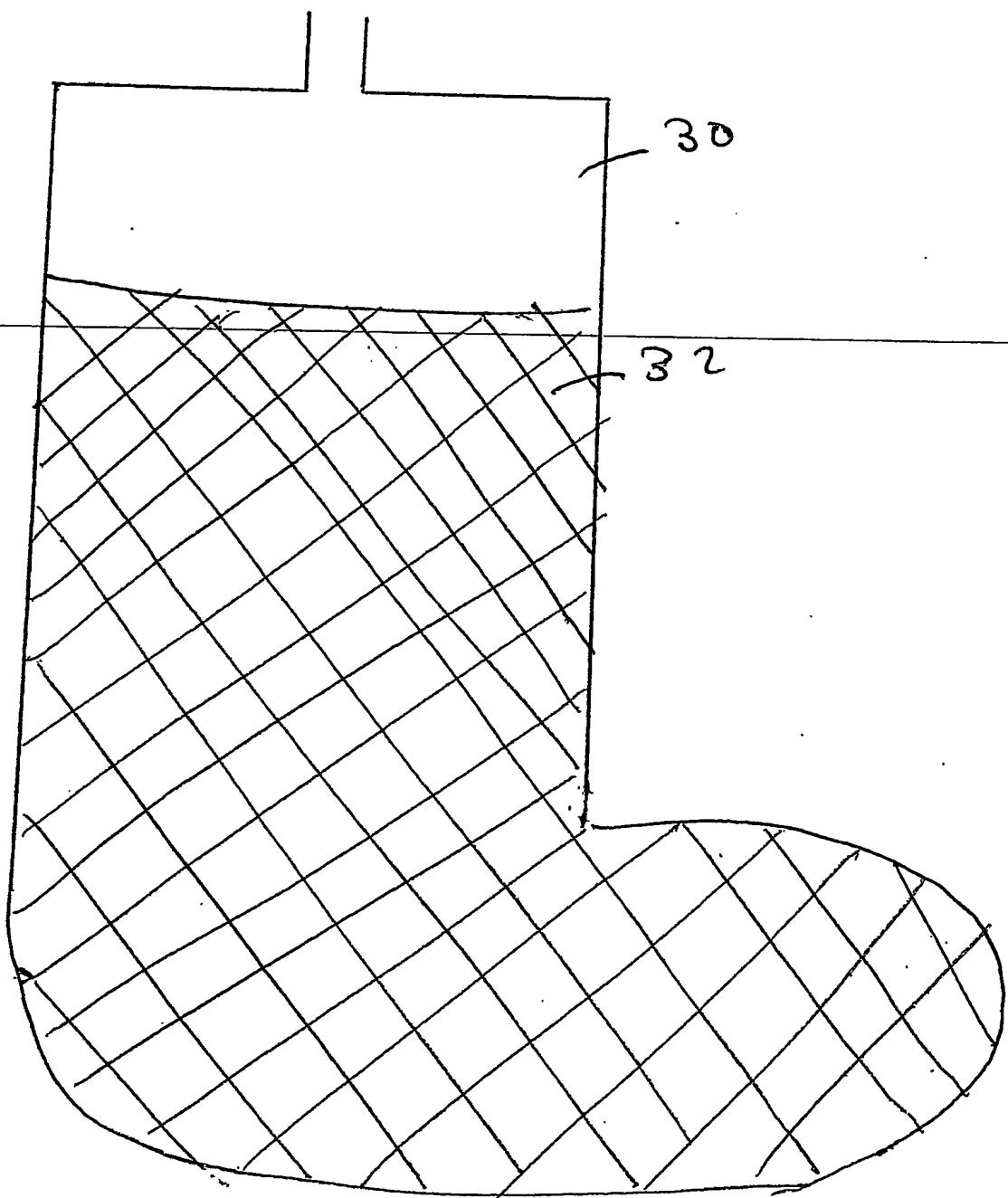


Figure 2

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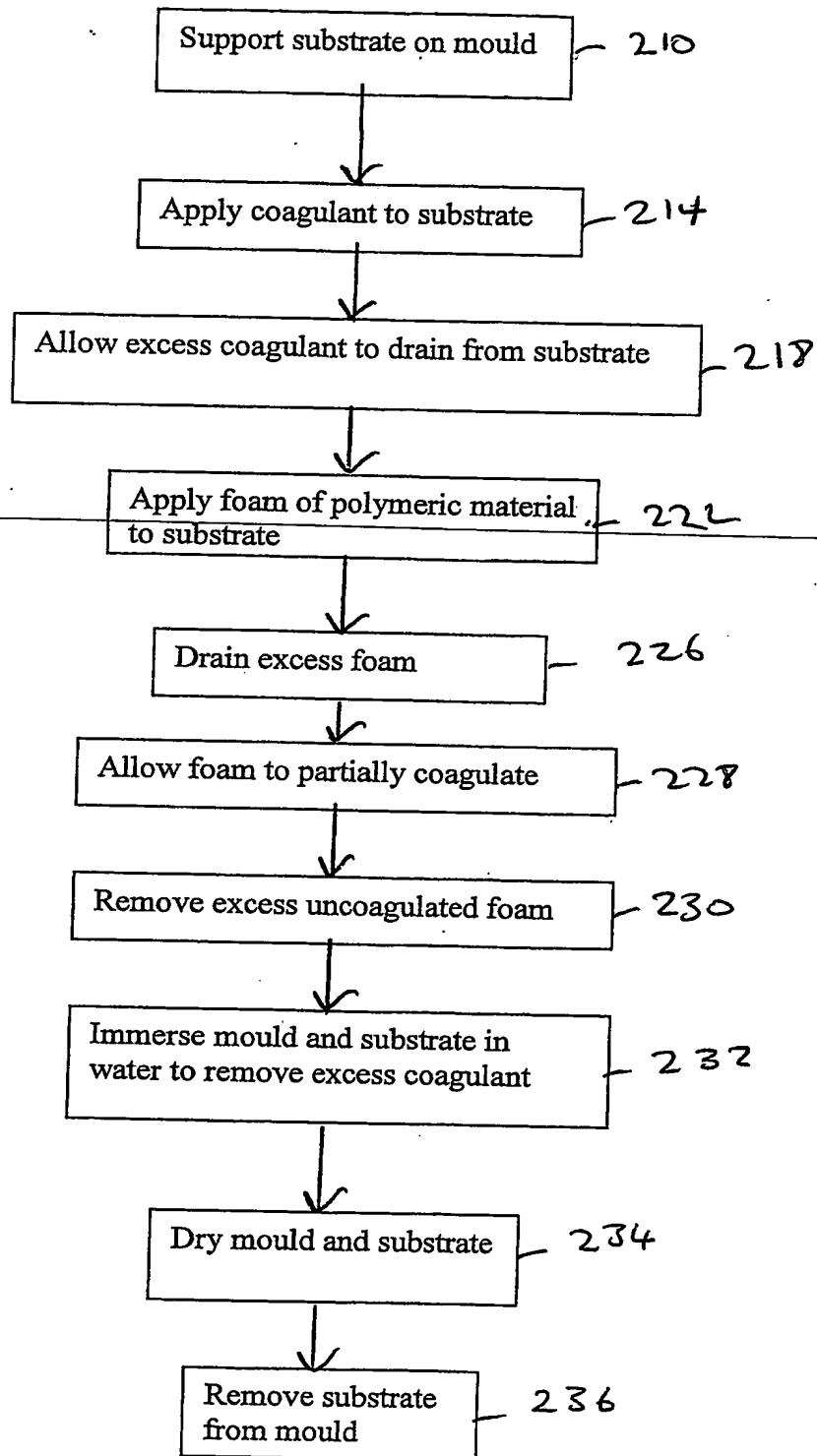
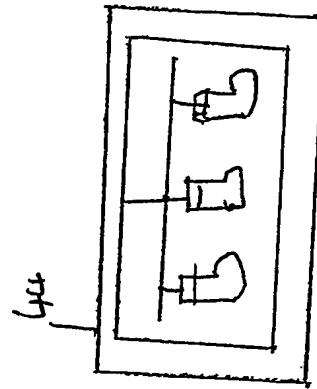
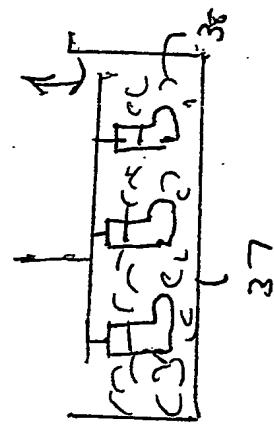
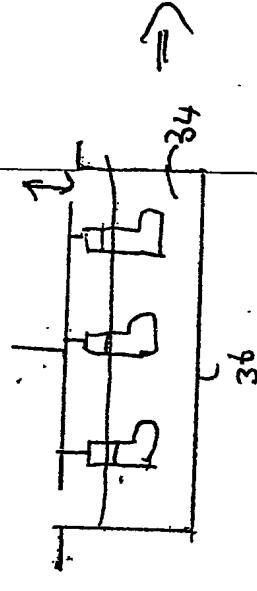
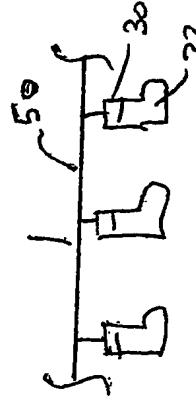
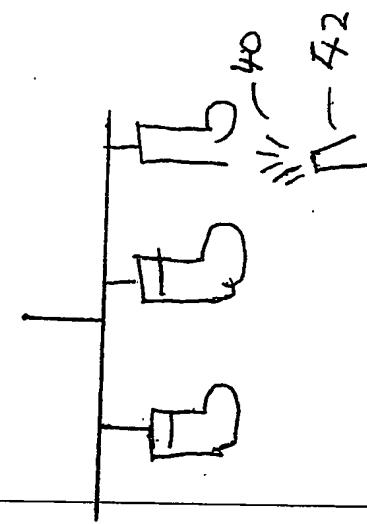
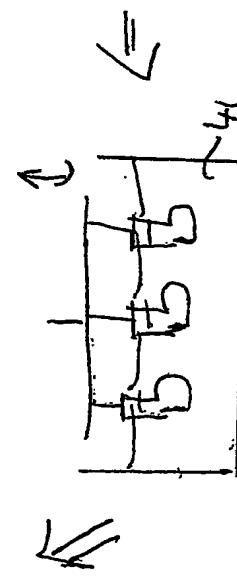


Figure 3



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Figure 4

Figure 5

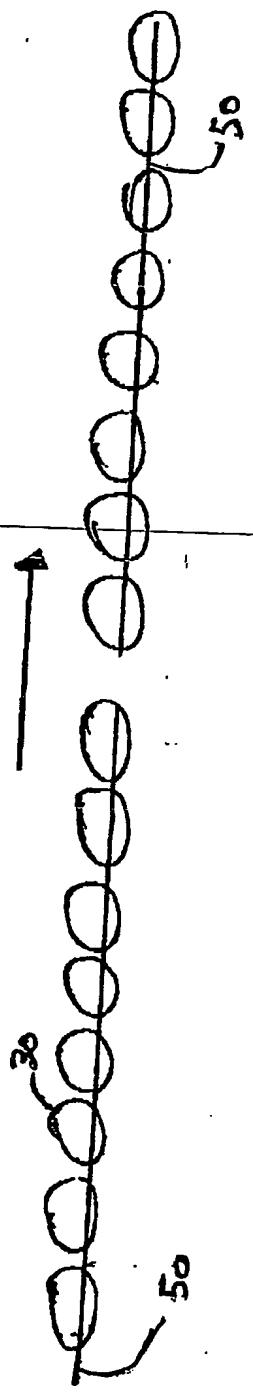
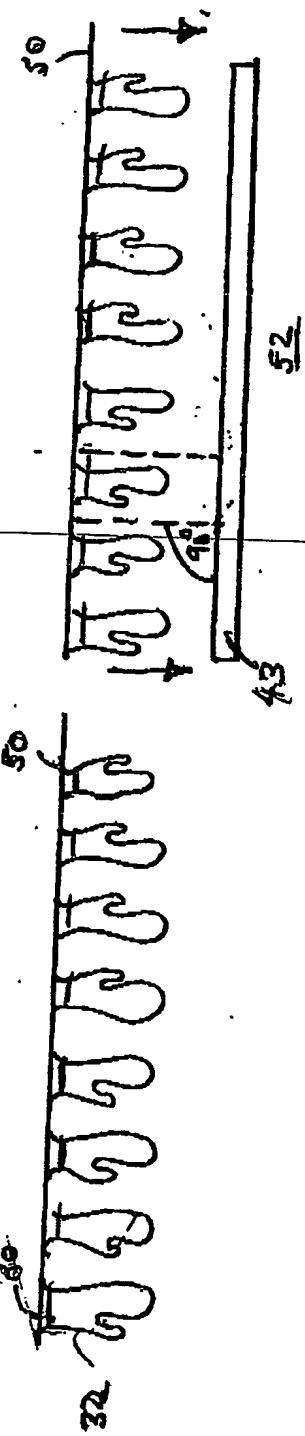


Figure 6



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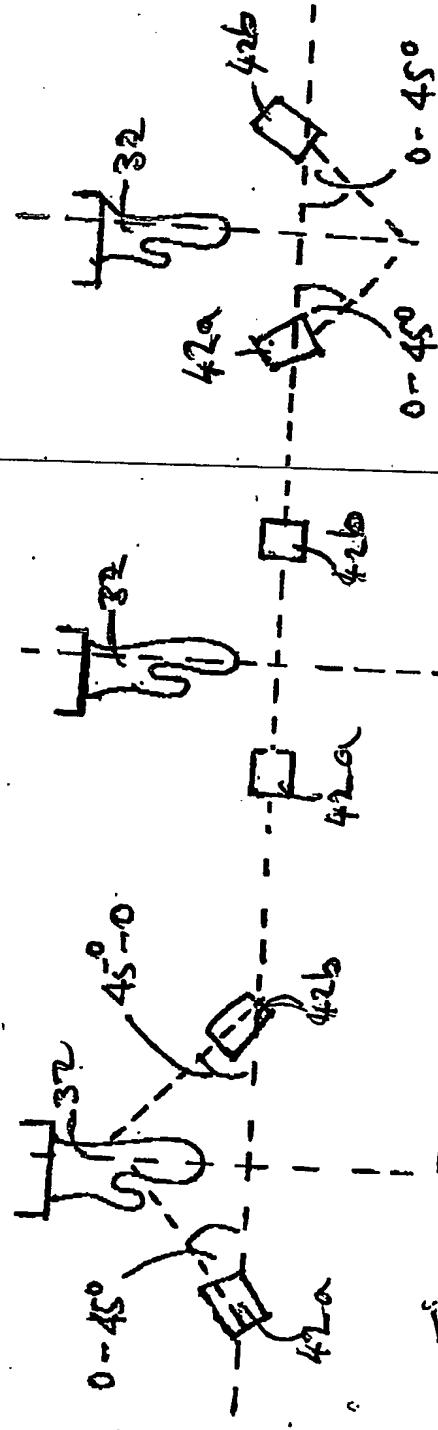


Figure 7

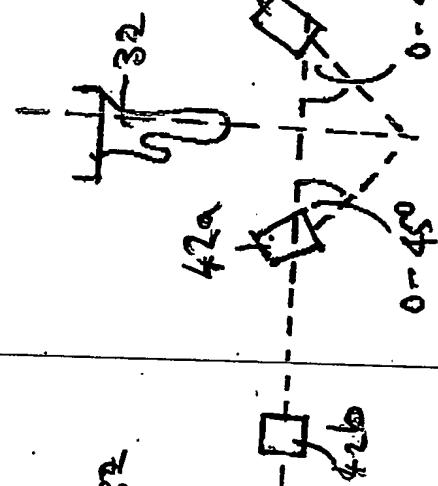


Figure 8

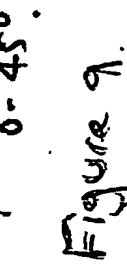


Figure 9

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